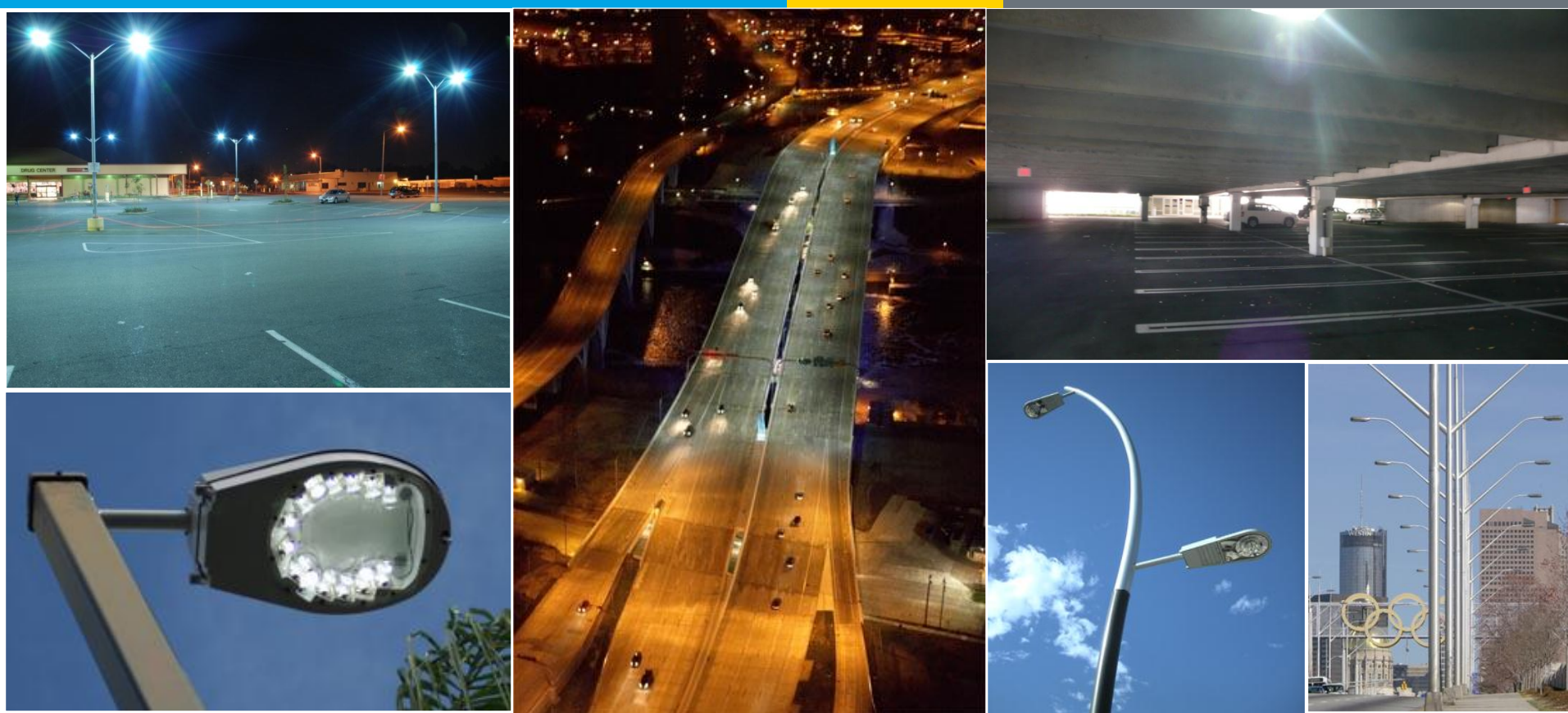


Solid-State Lighting for Exterior Applications

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



2011 Asia Pacific Clean Energy Summit and Expo

September 13, 2011

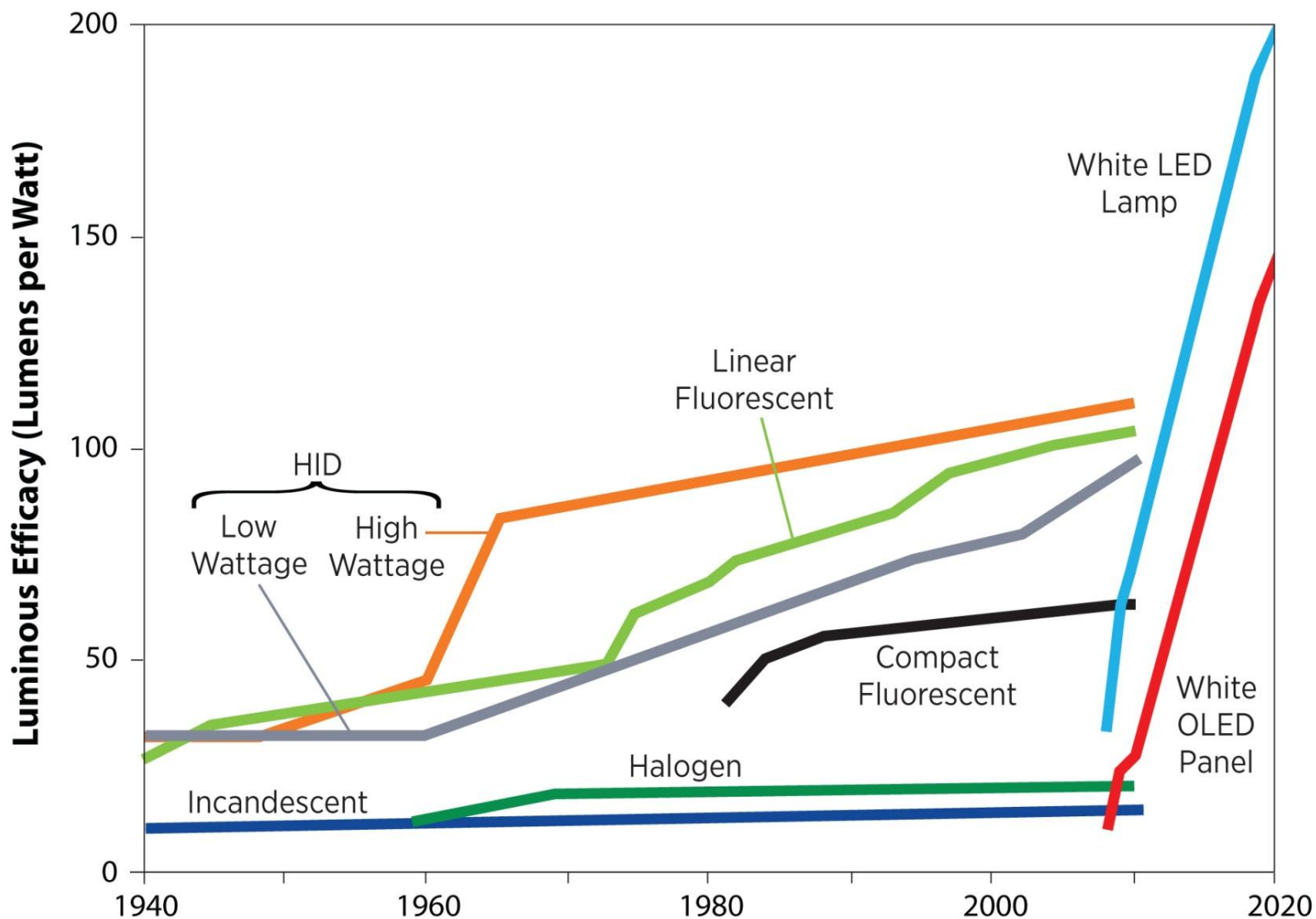
Jeff McCullough, LC

Pacific Northwest National Laboratory
Richland, Washington

Energy Savings Potential of Solid-State Lighting

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SSL Multi-Year Program Plan, May 2011: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2011_web.pdf

A Market in Motion

- Tsunami of new products coming to market
- Significant learning curve for both manufacturers and buyers
- SSL is fundamentally different from conventional technologies
- Unfamiliarity and lack of field data mean increased risk
- Lots of hype and misinformation



- CALiPER: Independent lab testing of commercially available LED and benchmark products
 - Over 350 products tested; reports available
- GATEWAY: Demonstrations of LED products in real applications
 - Lessons learned; reports available

LOOKING GOOD	NOT COMPETITIVE YET
<ul style="list-style-type: none">• Recessed downlights• Outdoor, parking garage, wall pack luminaires• Refrigerator case lighting• 2' x 2' troffer luminaires	<ul style="list-style-type: none">• 4' linear replacement lamps• Small replacement lamps• Cove lighting (when replacing linear fluorescents)

CALiPER data, www.ssl.energy.gov/caliper.html; GATEWAY data, www.ssl.energy.gov/gatewaydemos.html

- Projects implemented must save energy, be cost effective, meet expectations for quantity and quality of illuminance
- Purpose:
 - Comparison of LED with incumbent technologies
 - Comparison of rated values with measurements
 - Feedback for manufacturers
 - Objective information for utilities, municipalities, large purchasers
 - Tracking of year-to-year technology progression
 - Long-term performance monitoring



New York, NY



Chicago, IL

LED Parking Lot Lighting Leavenworth

- System designed using DOE site lighting performance specification
- 63% energy savings relative to metal-halide baseline
- 6- to 10-year simple payback period
 - \$0.06 / kWh for electricity



LED	
Avg. Horizontal	1.3 fc
Min. Horizontal	0.8 fc
Max:Min	2:1
W/sf	0.04

LED Parking Lot Lighting Manchester

- LED improved both uniformity and minimum illuminance
- Incorporates motion sensors and dimming control
 - 53% energy savings without dimming
 - 74% estimated with dimming
- 3 year simple payback period (retrofit)
 - 0.14/kWh for electricity and high maintenance \$\$
- Ongoing monitoring: luminaires and motion sensors



Photo credit: CBT Development

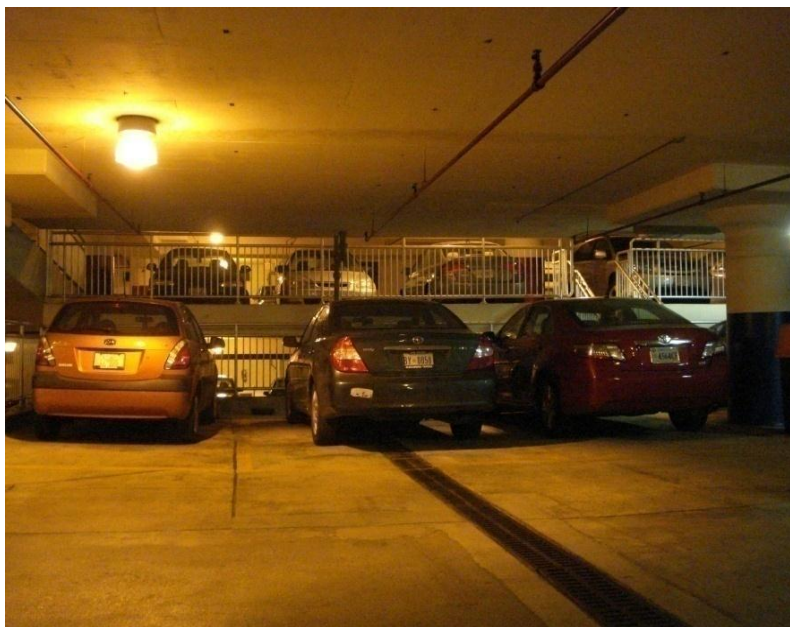
Criterion	400W HPS	LED (full output)
Avg. Horizontal	3.8 fc	2.0 fc
Min. Horizontal	0.6 fc	1.0 fc
Max:Min	28:1	3:1
Input	496 W	235 W

LED Roadway Lighting Palo Alto

- Compared HPS, LED, and induction light sources
- Also evaluated remote monitoring/dimming

Street	Source	Input	Average	Avg:Min	CV	Retrofit NPV
Colorado at Bayshore	HPS	96W	0.44 fc	15:1	1.22	
	LED-20	42W	0.24 fc	12:1	1.08	\$122
	Difference	-56%	-45%			
Colorado at Louis	HPS	96W	0.36 fc	18:1	1.05	
	LED-30	54W	0.43 fc	43:1	1.04	-\$15
	Difference	-44%	+19%			
Amarillo	HPS	96W	0.27 fc	27:1	0.90	
	Induction	90W	0.23 fc	23:1	1.23	-\$173
	Difference	-6%	-15%			

- Minimum horizontal illuminance increased 21%
- Average horizontal illuminance decreased 53%
- 55% wattage reduction, 77–85% kWh energy savings
- 1:1 replacement, approx. 8-yr simple payback (retrofit)



Before (HPS)



After (LED & motion)

Completed GATEWAY Projects

- Reports available online:

www.ssl.energy.gov/gatewaydemos_results.html



LED T8 Replacement Products: Seattle, WA (May 2011)



LED Roadway Lighting: Palo Alto, CA (June 2010)



LED Street Lighting: San Francisco, CA (Dec. 2008)



LED Parking Lot Lighting: Leavenworth, KS (May 2011)



LED Street Lighting: Portland, OR (Nov. 2009)



LED Parking Garage Lighting: Portland, OR (Nov. 2008)



LED Retrofit Lamps: San Francisco, CA (Nov. 2010)



LED Freezer Case Lighting: Eugene, OR (Oct. 2009)



LED Residential Downlights and Undercabinet Lights: Eugene, OR (Oct. 2008)



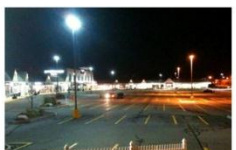
LED Museum Accent Lighting: Chicago, IL (Nov. 2010)



LED Roadway Bridge Lighting: Minneapolis, MN (Aug. 2009)



LED Walkway Lighting: Atlantic City, NJ (March 2008)



LED Parking Lot Lighting: Manchester, NH (June 2010)



LED Parking Lot Lighting: West Sacramento, CA (Feb. 2009)



LED Street Lighting: Oakland, CA (Phase III, November 2008; Phase II, January 2008)

www.ssl.energy.gov/gatewaydemos.html

- Share experiences, best practices, lessons learned from LED street lighting demonstrations
- Regional workshops: Provide forum for education, collaboration on specifications and tools
- Demonstrations: Kansas City, MO; Sacramento, CA; Philadelphia, PA; Seattle, WA
- Resources: Draft Model Specification for LED Roadway Lighting; task group on Remote Monitoring & Adaptive Lighting Controls

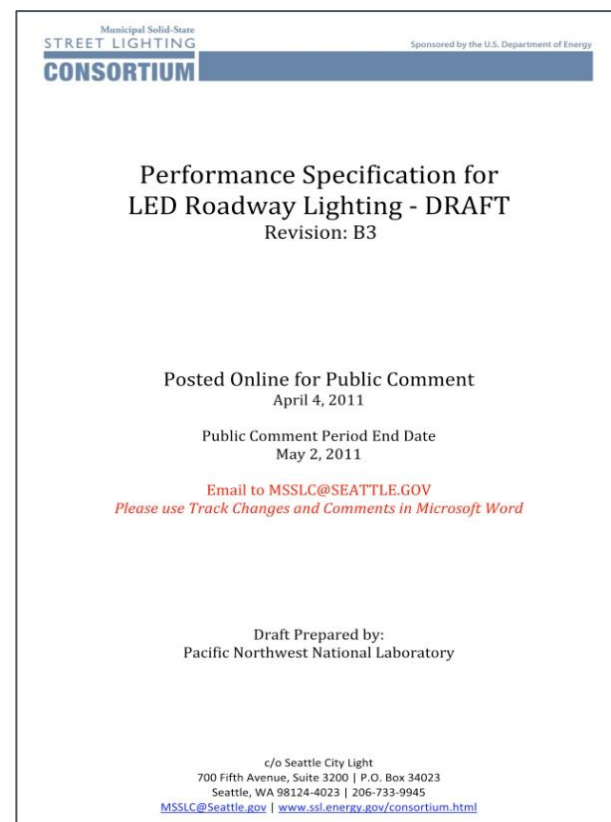


Photo credit: Ryan Pyle

Municipal Solid-State
STREET LIGHTING
CONSORTIUM

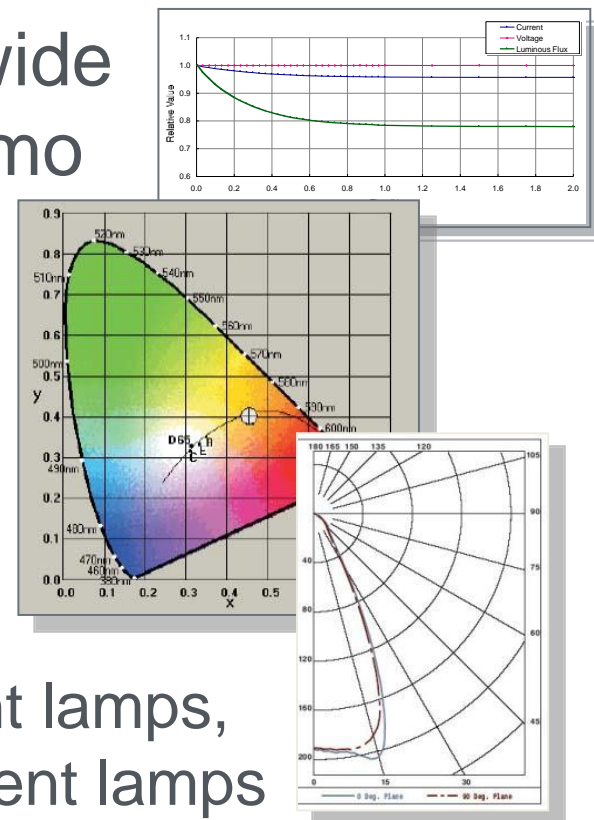
Model Specification for LED Roadway Lighting

- For use by municipalities, utilities, ESCOs as template to be edited by each user
- Provides a common language, framework, and checklist
- Appendix A provides consolidated criteria for each luminaire type, evaluating at site/system or luminaire/material level
- Draft published for public comment; final version expected in September 2011

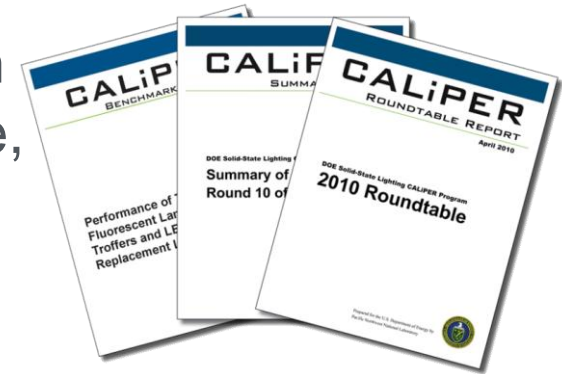


CALiPER Guides Planning and Fosters Developing Market

- Supports independent testing of wide array of SSL, benchmark, and demo products
 - Guides DOE planning
 - Informs development of standards and test procedures
- Rounds 1–12 completed
 - Includes roadway, linear replacement lamps, high-bay luminaires, small replacement lamps
- Reports available online



- Summary reports provide detailed analysis of results for all products tested in each round
- Detailed test reports provide results for each product tested; available through searchable, sortable database
- Benchmark reports compare LED products with conventional lighting technologies
- Exploratory studies provide nuanced analysis of test results related to critical issues (e.g., reliability, color shift)



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Solid-State Lighting

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Search using any or all data fields, for a comparative listing of information from CALiPER detailed reports. Multiple selections are allowed within round number and category fields.

Category: All Cove Downlight Outdoor Area - Post Top

Test Date From: 7/28/2006 To: 6/13/2011

Sort By: [Dropdown] Round #: 9

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You search results below were based on your search for:

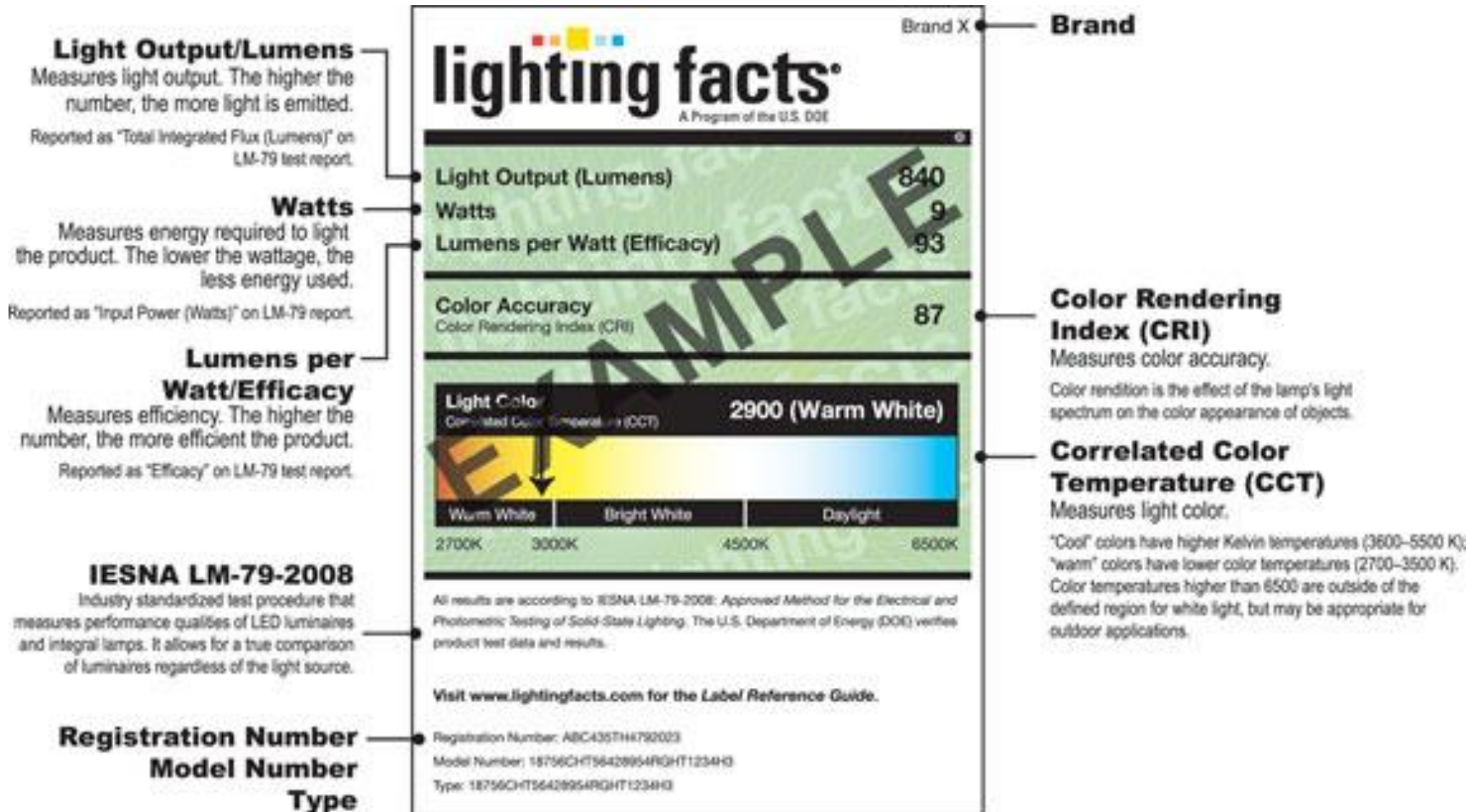
Category: All

Round: All

Test Date: From 7/28/2006 To 6/13/2011

Thumbnail	Light Source	Category	Round	Test Date	CALiPER Database	Power (W)	Initial Efficacy (lm/W)	CCT (K)	CRI	Power Factor	Report
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- www.lightingfacts.org





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Technical Requirements Table v1.6

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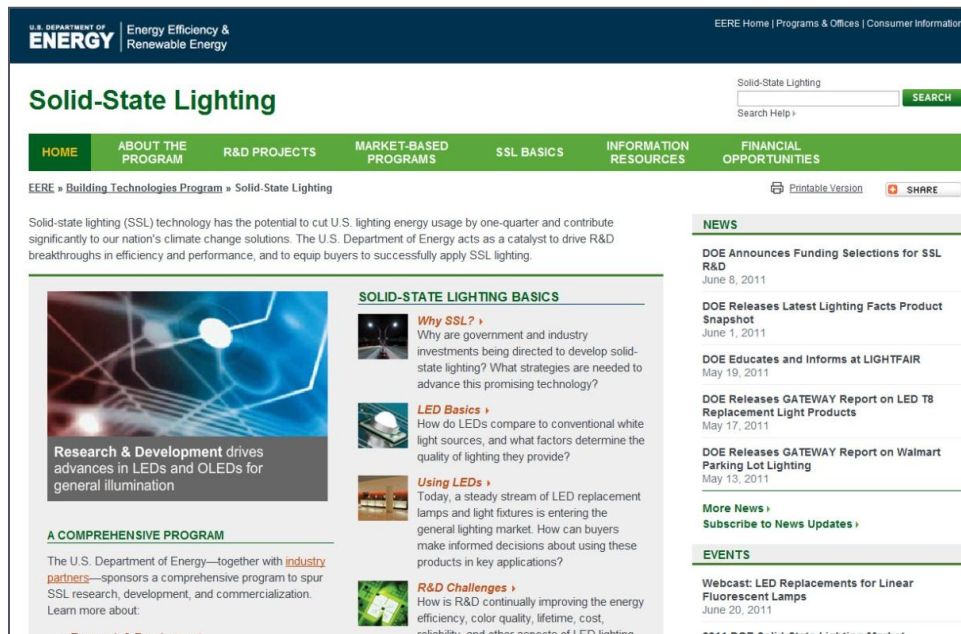
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Designlights™ Consortium Qualified Products List- Non-Residential Applications – Submit any or all of the following product information and Testing Results to Designlights for qualification *please make note that it is ONE per submission*							
PDF Download							
Application	Minimum Light Output	Zonal Lumen Density ²	Minimum Luminaire Efficacy	Allowable CCTs (ANSI C78.377- 2008)	Minimum CRI	L70 Lumen Maintenance	Minimum Luminaire Warranty
1) Outdoor Pole / Arm- Mounted Area and Roadway Luminaires	1,000 lm	≈100% 0-90°, <10% 80-90°	60 lm/W	≤5700K	50	50,000 hrs	5 years
2) Outdoor Pole / Arm- Mounted Decorative Luminaires	1,000 lm	≥65%: 0-90°	40 lm/W	≤5700K	50	50,000 hrs	5 years
3) Outdoor Wall- Mounted Area Luminaires	300 lm	≈100% 0-90°, <10% 80-90°	60 lm/W	≤5700K	50	50,000 hrs	5 years
4) Bollards	500 lm	<15%: 90- 110° 0%: >110°	35 lm/W	≤6500K	50	50,000 hrs	5 years
5) Wall-wash Luminaires	575 lm	≥50%: 20-40°	40 lm/W	2700K, 3000K, 3500K, 4000K, 4500K, 5000K	50	50,000 hrs	5 years
6) Parking Garage Luminaires	2,000 lm	≥30% 60-80°, ≤25% 70-80°	60 lm/W	≤5700K	50	50,000 hrs	5 years
7) Fuel Pump Canopy	2,000 lm	≥40%: 0° to 40°; ≥40%: 40° to 70°	70 lm/W	≤5700K	50	50,000 hrs	5 years

- Current information on SSL program, progress, and events
- SSL publications
 - Roadmaps
 - Reports
 - Technical fact sheets
- Solicitations
- Register for ongoing SSL Updates



www.ssl.energy.gov

www.ssl.energy.gov/gatewaydemos.html

www.ssl.energy.gov/consortium.html

www.ssl.energy.gov/caliper.html

Jeff McCullough, LC
Pacific Northwest National Laboratory
jeff.mccullough@pnl.gov
(509) 375-6317